Before the

FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Promoting More Efficient Use of Spectrum	)	ET Docket No. 10-237
Through Dynamic Spectrum Use Technologies	)	
	)	
To: The Commission	)	

COMMENTS OF IEEE DYSPAN STANDARDS COMMITTEE ON PROMOTING MORE EFFICIENT USE OF SPECTRUM THROUGH DYNAMIC SPECTRUM USE TEHCNOLOGIES

The IEEE DySPAN Standards Committee (DySPAN-SC) hereby submits its Comments on the above-captioned Proceeding. The document was prepared and approved unanimously by the 1900.1, 1900.4, 1900.5, and 1900.6 Working Groups within the DySPAN-SC [1] [2].

The IEEE DySPAN-SC is the leading consensus-based industry standards body for Dynamic Spectrum Access Networks (DySPAN), and has the following technical scope:

- dynamic spectrum access radio systems and networks with the focus on improved use of spectrum,
- new techniques and methods of dynamic spectrum access including the management of radio transmission interference, and

[1] The IEEE DySPAN Standards Committee was formerly known as the IEEE Standards Coordinating Committee 41 (SCC41).
[2] This document represents the views of the IEEE DySPAN-SC. It does not necessarily represent the views of the IEEE as a whole or the IEEE Standards Association as a whole.

- coordination of wireless technologies including network management and information sharing amongst different dynamic spectrum access radio networks.

We appreciate the opportunity to provide these comments to the Commission.

INTRODUCTION

1. The IEEE DySPAN Standards Committee commends the Commission for its work in developing this NOI and for starting this Proceeding on Promoting More Efficient Use of the Spectrum Through Dynamic Spectrum Use Technologies.

2. The IEEE DySPAN Standards Committee (DySPAN-SC) strongly supports the Commission's statement that dynamic spectrum access technologies and techniques have the potential to enable more efficient utilization of precious spectrum resources. The DySPAN-SC further believes that the benefits of the dynamic spectrum access techniques requires a regulatory framework that will encourage business development of products and services that utilized advanced DSA technologies. The acceptance of these advanced technologies by both the business and regulatory communities is dependent on DSA standards developed by international Standards Development Organizations (SDOs) such as the IEEE DySPAN-SC. Thus, the regulatory community, the wireless industry, and the Standards Development Organizations must work in close harmony to achieve the spectrum efficiency benefits associated with DSA radio systems and networks. This Proceeding is a critical component of creating this harmonious relationship.

3. In the text below, the DySPAN-SC provides comments on several sections of the NOI, including sensing techniques, cooperative sensing, sensing integration,

propagation models, policy radio, policy types and policy hierarchies, the Spectrum Dashboard, frequency bands suitable for DSA, FCC participation in standards development, and definitions.

SENSING TECHNIQUES (NOI SECTION 21)

The IEEE DySPAN 1900.6 WG completed a survey of sensing techniques which is available on the DySPAN webpage [1]. The survey analyzes the pros and cons of single sensor techniques like matched filtering, feature detection (e.g., cyclostationarity detectors) and energy detection, as well as multiple sensor architectures for collaborative or cooperative sensing. Real signal testbeds have also been analyzed. This survey concluded that the selection of the detection scheme highly depends on the usage scenario and the selection criteria. For instance, in terms of sensitivity, when more a priori knowledge about the signal to detect is available, the sensor can achieve a higher sensitivity. Therefore, whenever the waveform of the signal to be detected is known, matched filtering or feature detection will provide the best results. On the other hand, energy detection has a lower implementation complexity and can be applied without prior knowledge of the signal types operating in the electromagnetic environment, however, it generally cannot detect with the same level of accuracy. [2] provides implementation examples of feature detectors applied to WiFi and DVB-T signals and discusses performance versus complexity in a thorough manner.

R21-1: (What innovations to sensing are contemplated?)
Sensing must be adaptable to different wireless environments and scenarios. Therefore, innovations are envisioned which increase the flexibility of the sensing module. Sensing will become more intelligent, with mobile terminals able to choose the best sensing method according to their own capabilities and the current operating environment. It will be common place that sensing content also includes geographical information.

Distributed sensing may be implemented in large scale networks such that sensing results are shared among users. The user will theoretically have a more complete picture of the electromagnetic environment, enabling more precise spectrum access decisions and efficient network operation.

R21-2: (How should the detection threshold for spectrum sensing be determined?)
Theoretically, given the performance of the spectrum sensing method, the signal and noise levels, and the necessary detection and false alarm probabilities, an appropriate sensing threshold can be determined. In reality, some factors, such as signal and noise levels, are difficult to obtain. Therefore, the device will use estimated values when needed, which can lead to inaccuracy of the sensing threshold.

The decision threshold is typically set to achieve a given probability of false alarm (Pfa). With the Pfa, the performance of the probability of detection (Pd) versus SNR response of the detector can be calculated. It is very important to be able to accurately determine the noise level. The primary concern is to set a threshold that does not depend on the input power (signal + noise), and to know whether the SNR value lies in a range which is acceptable for detector performance (i.e. Pd higher than a given SNR value).

Any inaccuracy in determining the threshold can be amended by sending a training signal. When a sensing node does not detect any incumbent radio signal present, it may ask another node to imitate incumbent radio terminal and send a training signal which is identical incumbent radio signal. This training signal helps the spectrum sensing device to adjust its threshold and have a better chance of detecting the incumbent.

Calibrating a sensor before being exposed to a specific electromagnetic environment proves difficult, as the noise in the operating environment is complex, and comes from interferers, white noise, etc. Determining the noise level while operating also proves complex, as the sensor does not 'know' whether the signal to detect is present. This means that calibration must be performed without any assumptions as to the exact makeup of the electromagnetic environment. Some tricks can be found to achieve this calibration, but they highly depend on the detection algorithm being implemented within the sensing system. In [2] for instance, the authors suggest to use specific cyclostationary taps where the signal is known to be absent (i.e. taps that null the cyclostationary response of the signal).

<u>R21-3: (What factors impact detection time and how do they vary for different incumbent radio services (e.g., land mobile systems versus radar systems)?)</u>
Computing the detection time consists of two parts: the calculation time and the sampling time. The calculation time depends on the algorithm complexity as well as the device's calculation speed. And the sampling time is determined by the SNR, as well as the characteristics of the incumbent radio signal.

Detection time is directly related to the sensing performance. In [2] and [3], it is shown how WIFI or DVB-T signal detection is improved by increasing sensing duration. On the other hand, the time upon which a cognitive radio system must vacate a channel after primary setup, gives some upper bound to the sensing duration as discussed in [3] which computes the time between sensing and when the band is evacuated to determine the shortest opportunities that can be exploited.

As for radar systems, the sampling time must be long enough to allow at least one radar pulse to be present. For example, considering a radar system with pulse per second (PPS) at 1000Hz, the sampling time must exceed 1ms. Otherwise, during the sampling time, there may not be any radar pulse present even if the radar system is operating.

<u>R21-4: (Can a common standard for spectrum sensing be developed? What would need to be included in such a standard?)</u>
As mentioned in our answer to question R22-1 (B), there are various options to sensing which cannot be clearly selected or ranked. Thus, we believe that the design and selection of an appropriate scheme should be based on performance and usage specification

figures, rather than through standardization. However, we believe that having a standardized interface between these sensors and other entities is a guarantee that innovation can be quickly deployed into industrial products, and fosters innovation on sensing techniques Therefore standardization effort towards a unified sensor interface is of paramount importance. This effort is currently being carried out by the IEEE DySPAN 1900.6 WG.

Standardizing a sensing technology agnostic interface is the best way to benefit from the latest sensing techniques as they mature: this standard has to consider thoroughly the continuous progress in technologies for sensing, sensing data fusion and communication of sensed data as well as related sensor technologies and sensing algorithms. The standard must not put any limits on sensing technologies, sensing algorithms and data fusion algorithms and needs to consider evolving technologies for incorporation into the standard on a feasible time scale.

The standard will have to set the data and control structures and format to enable multi-vendors solutions by guaranteeing the interoperability of equipment and devices. Indeed, it is very likely that the entities of the cognitive radio, which are diverse in nature, will come from different industry profiles: terminal manufacturers, infrastructure manufacturers, database servers and maintainers, etc. Ultimately, protocols for these interfaces shall be determined as well. Therefore the standard must be detailed and precise in sensing data communication formats and must provide reliable and stable definitions of extensible interfaces and sensing data structures used in communication of sensing data and interfacing with spectrum sensors.

- The standard must be open to upcoming sensor and sensing technologies to ensure applicability to a variety of frequency bands, types of incumbents encountered, and types of secondary use not yet considered by regulations on the near term beyond TV bands. It further must be applicable to sensing other secondary users in, for example, shared secondary-only use of spectrum.

- The standard must foresee and incorporate candidate migration paths towards more sophisticated sensing algorithms potentially also putting stricter limitations and requirements to conforming sensing equipment and algorithms than before within the same framework and architectural assumptions.

- The standard must consider a reasonable degree of self-configuration capabilities providing a framework for dependable and extensible control and configuration protocols as well as electronic data sheet formats for spectrum sensors and collections thereof. Thus, spectrum sensors must be self-descriptive to a certain degree.

- The standard must address interoperability with and use of existing communication protocols, interfaces and interface data structures to create a broad industrial acceptance. This is crucial for both having spectrum sensing capacity widely integrated into RF transceiver chain designs, and for allowing distributed sensing infrastructures to integrate with commonly used network management platforms.

- The standard must provide a sound basis for spectrum sensing equipment conformance tests and equipment certification based on specifications of the interface behavior and on performance criteria of the spectrum sensing process. Both objectives must be addressable separately by a) conformance testing of protocols and procedures at the communication interfaces and b) performance evaluation of the particular sensing algorithm utilized. The standard must address the latter by providing a generic framework of testing procedures and interface functions for build-in testing functions.

The standard thus should provide distinct specifications for functional and operational profiles covering the three main areas of sensing technologies: sensor technology, requirements to sensing algorithms and sensed data communication requirements. The standard then should allow combining profiles from these distinct areas into a dedicated spectrum sensing application.

<u>R21-5: (How can dynamic spectrum access radios avoid adjacent channel interference to incumbent systems?)</u>
Adjacent band leakage depends on the spectrum response of the communication system and implementation related specifications (filtering). To minimize adjacent channel interference, the following measures should be taken (even jointly):

1. Consider frequency guard interval. This impacts the spectrum efficiency.
2. Insert ghost signal that impacts the frequency response without damaging the wanted signal (e.g. specific values on some dedicated or pilot carriers for OFDM signals).
3. Consider advanced waveforms with steep spectral roll-off.
4. Sense adjacent bands to ensure that channels where side lobes are high are vacant as well.

<u>COOPERATIVE SENSING (NOI SECTION 22)</u>

<u>R22-1: (Have there been studies regarding which sensing methods work best among using matched filters, simple energy detection, or cyclostationary detection or other techniques?)</u>
There is no single sensing method which is best suited for all sensing scenarios. Due to the complicated wireless environment, different sensing methods should be used to maximize performance and meet specific system requirements. For example, in the DVB-T case, the broadcast nature of the signal can be exploited to expand sensing duration so as to increase detection sensitivity. Again, this has to be traded with the setup

time and the band evacuation lag. On the other hand, detecting of the FM analog modulation of PMSE equipment makes energy detection the best suited sensing method, with the trade-off of poor detection levels. Recent work has tried to incorporate features into an FM signal to enhance the capability for detection [4]. When unknown users are concerned, blind detection is the best approach. Although these techniques have a lower sensitivity, they can be very helpful to coexistence management among secondary unlicensed users. (see also response to question 21).

SENSING INTEGRATION (NOI SECTION 24)

R24-1:
We believe that the integration of sophisticated spectrum sensing techniques with geolocation database services will significantly increase spectrum use efficiency and protection of licensed spectrum users beyond the capacity of state of the art approaches based on the modeling of radio propagation and terrain.

The increase in dependability and accuracy is expected to result from

- A continuous verification of models by (potentially) real-time measurements at the location of potential victim devices and at the location of registered secondary spectrum users;
- An almost instantaneous detection of changes in the propagation models (e.g. caused by a natural phenomenon or by human-made impact) with respect to those known and applied by the geolocation database;
- A capacity to instantaneously detect malicious use as well as defects of a device or of the geolocation database itself.

We further believe that the integration of sensing capacities into upcoming RF transceiver chain designs will enable a wide use of this approach, since it can be assumed that reporting of spectrum measurements towards an enabled geolocation database infrastructure can be made the default behavior of upcoming dynamic spectrum access technologies at reasonable cost. An expectation of additional frequency spectrum available to dynamic spectrum access technologies in a proper time frame will encourage stakeholders to make low-cost sensing capabilities available in their product design.

Standardization of efficient protocols and suitable interfaces is considered crucial for a broad acceptance of a reporting sensing technology.

Given that an early rollout of first generation TV white space devices can be expected (e.g., from current standardization efforts in IEEE) for the time frame of late 2013 to early 2014. It is assumed that RF sensing enabled TV white space devices will hit the market in subsequent device generations when significant additional spectrum will be made available, demanding for enabling RF sensing capacities beyond state-of-the art dynamic frequency selection schemes.

The commercial benefit of sensing enabled geolocation databases will arrive immediately after the availability of mass-market RF transceivers with sensing capacity. An enabled geolocation database will then allow operators of these databases to benefit from a competitive situation by optimizing and fine-grain adjusting spectral and spatial safety margins, which allows them to offer a larger amount of spectrum to their customers along with an increase in incumbent protection.

PROPAGATION MODELS AND OTHER TECHNICAL CONSIDERATIONS (NOI SECTION 26)

Most or all existing propagation models do not possess the fidelity required to enable effective policy-based DSA radio systems (PBDRS). The propagation models currently used by the FCC and other regulatory bodies were developed to support the Command and Control or Exclusive Use models of spectrum management (SM). These SM models are targeted at long term propagation trends in support of long term spectral assignment and in the majority of cases are at their core based on assumptions of fixed transmitters and receivers with static antenna characteristics. Recently developed propagation models like the COST-Hata model are developed in support of the Commons model of spectral management and while they often support mobile as well as fixed radios, they are best suited for characterizing aggregate behaviors under typical assumptions and are not often applied to individual propagation performance in rapidly time varying conditions. These types of models will likely be used in conjunction with frequency and topology specific models to yield effective DSA radio system policy compliance. The deployed models must possess a level of accuracy to enable the cognitive engines in PBDRS to consistently yield the fidelity required for reliable and effective DSA.

A primary goal of PBDRS is to drastically increase spectrum usage via dynamic, adaptive, and opportunistic means. The market driven process of evolving these methods to the point of realizing this drastic increase in spectrum usage shall include dynamic waveform adaptation, dynamic power control, adaptive antennas, distributed antennas for disadvantaged nodes, dynamic network reconfiguration, MIMO radio configurations in multipath propagation environments, etc. At the same time, these policy-based DSA radio systems which employ cognitive features must coexist with non-cognitive transmitters and receivers that can neither sense their electromagnetic environment nor can they report there conditions, positions, or states in real time to the cognitive networks. Additionally, the greatest benefits of DSA are likely to be realized in dense and dense office and industrial urban environments where multipath and widely varying signal attenuation phenomena exist. If aggregated long term propagation models are applied exclusively in these situations then worst case propagation predictions will necessarily be presented to the policy reasoner as a “first do no harm” fall back, thus greatly diminishing the spectrum usage gains enabled by DSA.

During the development and deployment of PCS, WLAN and other wireless technologies many lessons have been learned in regard to the predictions of propagation models versus actual measured performance. A significant lesson learned is that accurate propagation models, especially those that are to characterize time-varying and varied topological conditions are highly frequency dependent. That is, propagation models cannot be both frequency general and accurate to specific conditions; models for predicting behaviors in dynamic conditions are highly frequency dependent and actually are more useful when developed nearly independently per frequency band of interest. To increase the accuracy of propagation models actual data must be taken in a number of representative environments, compared to the model prediction, and the model modified as required to achieve a required accuracy.

In the past decade there have been many band and application specific propagation models developed by industry and academia that demonstrate that one can develop highly accurate propagation models when the models are frequency restricted, the physical topology can be well defined, and when a large amount of heuristic data is available for evaluating the model. Good models exist for some bands while not for others relative to application to policy-based DSA radio systems. Further, the ultimate accuracy of and fidelity of any propagation model in these type of radio systems will depend on the amount and quality of environmental sense information, the detail of topological data or meta data, the level of refinement of the propagation model and the computational resources available. Thus frequency and topology specific propagation models shall have to be developed for bands in which they currently do not exist to support PBDRS and existing models shall be required to be modified to increased levels of fidelity. Additionally, it is highly likely that to reach the full potential of DSA relative to spectrum usage within the confines of policy limits, a set of base propagation models shall eventually be coupled to learning engines (the plural is used because the machine learning could be local, network wide, or global) to evolve their accuracy and effectiveness. This can introduce additional security and policy compliance issues as learned behavior shall have to be verified and the distribution of new models shall have to be tamper resistant to prevent the distribution of malicious propagation models that could be used to circumvent the policy conformance reasoner.

Examples of currently available models that may serve as starting points for deployable models with required fidelity include the COST231 model, COST Walfisch-Ikegami model, the Rayleigh fading channel model, Ricean and Nakagami models, the TGAD channel model, the shadowing model, the small-scale path loss model, the Young model, the Okumura model, the various Hata models, the Lee models, the Green-Obaidat model, and the various ITU indoor attenuation and extended terrain models.

POLCY RADIO (NOI SECTION 29)

The work being pursued by the IEEE 1900.5 WG within the IEEE DySPAN Standards Committee (formerly SCC41), is generally consistent with the FCC discussion in Section 29, Policy Radios. The IEEE DySPAN Standards Committee (DySPAN-SC) is hereby providing an elaboration of the FCC discussion on policy radio including a brief description of current and planned DSPAN-SC standards activities related to policy radios.

It is noted that the description of policy radio in the first sentence of Section 29 is consistent with, but not the same as the definition of policy radios as provided in the published IEEE 1900.1 Standard. [3]

The IEEE 1900.5 Working Group under the DySPAN-SC has completed a final draft of a standard entitled: "P1900.5 Draft Standard for Policy Language Requirements and System Architectures for Dynamic Spectrum Access Systems."

The Scope of this standard is:

> This standard defines a vendor-independent set of policy-based control architectures and corresponding policy language requirements for managing the functionality and behavior of dynamic spectrum access networks.

The Purpose of this standard is:

> The purpose of this standard is to define policy language and associated architecture requirements for interoperable, vendor-independent control of Dynamic Spectrum Access functionality and behavior in radio systems and wireless networks. This standard will also define the relationship of policy language and architecture to the needs of at least the following constituencies: the regulator, the operator, the user, and the network equipment manufacturer.

The DySPAN-SC believes that this standardization work as characterized by the title, scope and purpose are consistent with the FCC discussion in Section 29 of the NOI. Specifically, this standard includes the following:

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[3] **Policy Radio**: A type of **radio** in which the behavior of communications systems is governed by a policy-based control mechanism. *See also:* **policy-based control mechanism**.
NOTE 1—Policies may restrict behaviors (e.g., policies constraining time, power, or frequency use) associated with a specific set of radio functions, but they do not necessarily change the functional capability of a radio. Because policies often do not change basic radio functionality, a policy-based radio need not also be a reconfigurable radio.
NOTE 2—Because the definition for the term policy-based control mechanism considers radio policy to be a type of radio control software, the policy-based radio is considered a subset of software-controlled radio.

Policy-Based Control Mechanism: A mechanism that governs radio behavior by sets of rules, expressed in a machine-readable format, that are independent of the radio implementation regardless of whether the radio implementation is in hardware or software.
NOTE 1—The definition of rules and associated modification of radio functionality can occur:

a) During manufacture or reconfiguration
b) During configuration of a device by the user or service provider
c) During over-the-air provisioning
d) By over-the-air or other real-time control

NOTE 2—As implied by the scope of this standard, the control of radio dynamic spectrum access behavior is expected to be a typical application of a policy-based control mechanism. However, the concepts of policy-based control could be applied to network management policies as well. Policy sources include spectrum regulators, manufacturers, and network operators.

- Requirements for a policy language which is needed for a policy conformance reasoner and for supporting the Spectrum Policy Dashboard. This aspect of the policy language is described in our response to NOI Section 35 "Spectrum Dashboard."

- An architecture for policy-based DSA radio systems. The DySPAN-SC views that the high-level architecture and communication interface descriptions provided in the P1900.5 Draft Standard will be of interest to policy makers and regulators as they develop decisions relative to policy-based DSA radio systems. The components and interfaces of this architecture may be of value in accreditation of these types of systems.

The P1900.5 Draft Standard will be following the IEEE balloting process during the first half of 2011. The goal is to have a final published standard about 1 July 2011.

The DySPAN-SC views the P1900.5 Draft Standard as being a foundation standard, i.e., it is a baseline standard that will be followed by the development of additional standards that will utilize the initial standard as a foundation. Two additional standards, which will be developed by the 1900.5 Working Group, are planned:

1. Detailed descriptions of the architecture components and interfaces for policy-based control of DSA radio systems, and
2. Detailed technical specifications of the policy language.

The DySPAN-SC believes that especially the planned detailed specification of architecture components and interfaces are applicable to accreditation and certification issues. Initial planning discussions of these projects will commence in February. It is planned that detailed technical work on these two standards will be initiated during the second half of 2011.

TYPES OF POLICIES AND POLICY HEIRARCHIES (NOI SECTION 30)

The work being pursued by the IEEE 1900.5 WG within the IEEE DySPAN Standards Committee (formerly SCC41), provides the following insights to the FCC questions in Section 30, under Policy Radios. The IEEE DySPAN Standards Committee (DySPAN-SC) is hereby providing an elaboration of the concepts surrounding the definition, development and distribution of policies for use in policy radio devices.

Policy Definition

The use of the phrase "digital policy" in referring to machine read-able policy rules, can be helpful to avoid confusion over the many other types of policies related to DSA. Policy rules as described in the NOI are examples of the larger class of what is coming to be known as "digital policy." The Digital Policy Management Group, a

Federal/Commercial collaboration, formed in 2010 to develop standardized approaches to defining and managing digital policy across all possible applications to include digital policy for access to networks and data, digital policy for managing network operations, and to include digital policy for spectrum access.

The concept of digital policy for DSA creates a new mechanism for the granting of authority for use of spectrum. Digital Spectrum Policy in the simplest form can be identical to the current mechanisms for granting of a license or the issuance of a frequency assignment. Digital policy, however, allows for a more complex representation of spectrum rights, to enable more fine-grained control over the granting of authority to operate. In the initial fielding of DSA capable radios, it is expected that these new devices would be treated no differently from other spectrum dependent systems. The digital policy would define transmission rights for the DSA radios within the constraints of the US table of allocations and associated service rules. This is consistent with the US proposed response to the WRC-12 Agenda Item 1.19 regarding regulatory measures required for the introduction of software defined radios and cognitive radio systems.

Service rules are established to define the spectrum rights of the primary and secondary users. The objective of digital spectrum policy is to capture the rights of existing users in digital format that allows the radio to reason about the potential for local spectrum reuse, without interfering with existing users. Digital spectrum policy also captures additional constraints on spectrum use to achieve broader objectives of the national regulator, or another organization to which spectrum management authority has been granted. This is necessary to provide the regulator with the ability to control the use of DSA, for example, to allow multiple secondary systems to co-exist. Service rules may eventually change to accommodate more dynamic spectrum use. Digital policy could then be developed or modified to reflect the changes in the service rules.

Policy Development

The development of digital policy for DSA radios will be governed within the existing hierarchy of national authority. Authority for creating digital spectrum policy resides inherently with the national authorities for regulating spectrum use. In the US, the FCC and the NTIA are empowered under the Communications Act of 1934 to carry out this role. Each sovereign nation has similar regulatory agencies to govern the use of spectrum, to include digital spectrum policy development. The standardization of a digital spectrum policy language and architecture not only benefits device developers and service operators, but also benefits national regulatory agencies for national and inter-nation coordination of digital spectrum policy for dynamic spectrum access.

Authority for sub-leasing of spectrum can be conferred to the licensee or to the agency to which a frequency assignment has been made, but only within the constraints of the spectrum rights defined in the license or frequency assignment. Once conferred, the authority to create digital spectrum policy allows the licensee or frequency assignment holder to coordinate secondary use directly without need for direct involvement of the higher authority.

Digital spectrum policy must be authored and validated by an accredited tool to ensure that the expression of the policy is correct. The policy must be signed and protected during transfer to ensure it arrives at the end-user device without having been altered. The end-user device must be able to verify the signature of the policy and the reasoning engine in the device must be tested and certified to ensure that all policies are enforced as intended by the policy authority.

Policy Distribution (and updating)

A variety of solutions will likely exist to ensure that devices have current, valid policies. In most cases, it seems reasonable to assume that the radio device needs to connect to some policy infrastructure periodically. Policy will likely be assigned validity dates (either in groups or individually) beyond which the radio would have to deactivate the policy until it can reconnect with the policy infrastructure to coordinate with the cognizant digital spectrum policy authority for policy extension or modification. The time frame for validity of a digital spectrum policy will likely be determined on a case-by-case basis.

SPECTRUM DASHBOARD (NOI SECTION 35)

The FCC should extend the FCC Spectrum Dashboard to enable prospective sellers to advertise intent to share their spectrum usage rights and to specify their technical requirements for sharing. The API should allow prospective sellers to identify spectrum bands, geographical regions, time periods, and any limitations on buyer's hardware and software equipment beyond the restrictions already associated with the buyer's license, if applicable. The prospective sellers should be allowed to update or remove their advertised intents. The information should be captured and presented using a well-defined language in order to avoid misinterpretation and allow for automated querying and query result processing and analysis. The well-defined language is the policy language whose requirements are described in the 1900.5 standard described in DySPAN-SC response to NOI Section 29 "Policy Radios".

- FCC should promote the service to prospective sellers by providing means for the sellers to comprehensively and unambiguously capture requirements for secondary users to share the seller's spectrum usage rights.
- FCC should promote the service to prospective sellers by recognizing the FCC Spectrum Dashboard as the official US secondary spectrum access marketplace.
- FCC should further promote the service to prospective sellers by recognizing the seller's restrictions beyond the requirements attached to their license as binding to prospective buyers.

FCC should also extend the FCC Spectrum Dashboard to enable interested buyers to query for prospective sharing of spectrum usage rights by spectrum band, geographical region, and time frame. The FCC Spectrum Dashboard should allow interested buyers to query by describing portions of or limitations on their equipment. The query API and the query format should also follow a well-defined language.

- FCC should promote the use of the service by prospective buyers via advertising FCC's intent to share the TV whitespaces.
- FCC should further promote the service by using the service to advertise DFS and the unlicensed ISM bands.
- FCC should further promote the service and the general deployment of dynamic spectrum access technologies by recognizing the seller's restrictions beyond the requirements attached to their license as binding and allowing equipment meeting both the license and the seller's requirements to operate in the identified spectrum, location, and time, provided that the seller and the buyer reach an agreement.

IDENTIFYING FREQUENCY BANDS SUITABLE FOR DYNAMIC ACCESS USE (NOI SECTIONS 43 AND 44)

The IEEE DySPAN-SC applauds the FCC for seeking to identify frequency bands for DSA. We believe that such identification is a critical step needed to foster the further development and deployment of DSA technology. As a standards development organization, it is important for standards developers to know specifically which bands are available for DSA standards development.

The IEEE DySpan-SC has had discussions about the possible need for standards to support public safety and medical telemetry applications of DSA. Much activity has resulted in industry and in standards development organizations as a result of FCC rulings on TV white space. Similarly, it can be expected that identification of spectrum availability for DSA in other bands will result in similar increased activity in industry involvement in standards organizations such as IEEE DySPAN-SC.

FCC PARTICIPATION IN TECHNOLOGY AND STANDARDS DEVELOPMENT (NOI SECTION 55)

The Commission notes that it has participated in numerous conferences and forums related to spectrum access techniques and asks whether there are working groups and forums in which the Commission could participate. The DySPAN-SC invites the Commission to participate in any of its standards development activities, all of which are relevant to the Commission's objectives. As noted in the Introduction to the DySPAN-SC Response, the regulatory community, the wireless industry, and the Standards Development Organizations must work in close harmony to achieve the spectrum efficiency benefits associated with DSA radio systems and networks. As one example, it would be helpful for the standards development community to be mindful of the needs of the Commission for standards that support Certification, Authorization, Compliance and Enforcement.

DEFINTIONS (NOI SECTION 6)

The IEEE DySPAN-SC recognizes the importance of the common understanding of terminology. The 1900.1 Working Group has initiated the process of updating the IEEE 1900.1™-2008 Standard, "Definitions and Concepts for Dynamic Spectrum Access: Terminology Relating to Emerging Wireless Networks, System Functionality, and Spectrum Management."

SUMMARY

4. The IEEE DySPAN-SC again commends the Commission for initiating this Notice of Inquiry. We believe that future rulings by the Commission related to the efficient use of spectrum through dynamic spectrum use technologies are critical for the efficient use of our precious spectrum resources. The DySPAN-SC looks forward to participating in future NPRMs or NOIs on this topic. Additionally, the DySPAN-SC eagerly anticipates the development of standards that will support the deployment of DSA technology.

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